OBSERVATIONS

ON

RAILROADS IN THE UNITED STATES.

BY

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Sydney, 31 March, 1877.

Sir,

I have the honor to forward, for the information of the Government, the accompanying Report on American Railroads and their Plant. Properly speaking, the Report consists of memoranda made by me on such portions of the railway plant of the United States as appeared to me suitable for introduction into this Colony.

It may be that my anxious desire to have everything we require made in this Colony, and as cheaply as it could be imported, may have imperceptibly to myself influenced my opinions. But while I am confident that the simpler construction of American locomotives and rolling stock will enable us more readily to imitate them than the more complicated English patterns, I think I have stated sufficient reasons for concluding that the former have many points of superiority over the latter, and are better suited to colonial requirements.

As I have said in my report, so I again urge upon the Government, if it is intended to construct our railroad plant in the Colony, that the heads of the mechanical departments should be the most skilful and competent persons who can anywhere be found, even should it be necessary to pay much higher salaries than has hitherto been the custom.

The cause of the failure of new industries is almost always attributable to the incompetency of the management; and if we desire to retain the Government work for our own people, at reasonable prices, we must secure the services of the best talent to direct them.

Should anything I have written serve the interests of the Colony I shall be well satisfied, and I will gladly aid in giving effect to any recommendations of mine which may meet approval.

I have, &c.,

AUGUSTUS MORRIS,

Executive Commissioner to Philadelphia.

The Honorable the Colonial Secretary,

Sydney.

OBSERVATIONS

ON

RAILROADS IN THE UNITED STATES.

DURING my visit to the United States I endeavoured, as requested by the Honorable the late Minister for Works, to obtain as much information in regard to railroad matters in that country as possible. In the following report I will freely make such observations as have occurred to me; but I desire it to be understood that they are only what might be expected from an observer who has not the slightest claim to professional knowledge on the subjects he treats of. The facts can be depended upon as scrupulously accurate; and although the deductions I may have drawn from them may not always be correct, the facts themselves will enable competent persons to compare several American methods and some of their machinery with those adopted in this Colony. Report not professional.

What first struck me as different from the method of constructing railroads in this Colony was the comparatively light ballasting. This defect, however, is made up by the use of a greater number of ties or sleepers. On the best roads the sleepers average 2,640 per mile, and the rails are connected between the sleepers, thus preventing all jarring or jolting. The Pennsylvania railroad is laid with a double track of steel rails 67 lbs. to the yard. Its entire line is ballasted with broken stone 18 inches in depth, but the ties are all visible, and their ends extend beyond the ballasting, there being no curbing stones such as are to be seen on our railroads. Ballasting railroads.

Easy travelling.

It is not, however, the ordinary practice to ballast as heavily as this, nor are the ties as large as those on our lines. The American engineers seem content with numerous ties of oak or other suitable wood, and dispense with very heavy ballasting. Nevertheless the railroads of America are remarkably smooth and easy to travel on; the greater elasticity of their lines, or the better springs to the passenger cars, being the reason.

Freedom from accidents.

Serious accidents from defective construction of the lines are rare, except occasionally where a bridge has turned out faulty, as that at Astabula. Not a single accident occurred during the conveyance of the enormous multitudes of people to and from Philadelphia during the Exhibition which could possibly be charged to bad lines or the neglect of the railroad officials.

Mr. Higginbotham, the Engineer-in-Chief of the Victorian railways, says—"In the construction of the Pacific Railroad there are, as might be expected, marks of great haste observable, and very inferior and perishable material has in numerous instances been used."

Central Pacific Railroad well built.

I took some trouble carefully to examine into this matter, and I found that the best timber, such as red-wood, mountain cedar, spruce, and other equally suitable material were used for ties, and sugar and yellow pine for bridging, trestle-works, and snow galleries. All structures on that line, as careful inspection showed, are made of strong and heavy timber, and years of service confirm my view. The trestle-works, however, which Mr. Higginbotham terms "timber-framings crossing the valleys," have been since his visit abandoned, and earth-works, filled in upon arched stone culverts, have been substituted.

Outer rail on curves elevated.

It might be supposed that I had taken too favourable a view of the safety of American railroads, when we find Mr. Higginbotham stating, on page 20 of his report, that "no nice adjustment of the rails, such as is practised on English railroads, where the outer rail on curves is always elevated, would have been practicable on American lines. Even now on the best lines it is not adopted."

I also endeavoured to ascertain the facts in this case, and I am sure further inquiry will establish that there are no railways in the United States, unless some very exceptional one, of which I could hear nothing, where the outer rail on curves is not always elevated—some, however, more than others—according to the rate of speed at which the trains are run.

The elevation of the outer rail on the Central Pacific Railroad is calculated for a speed of 20 miles per hour, or a little more than a quarter of an inch to the degree of curvature. Mr. Higginbotham is correct when he says that "in America the practice of breaking joints is common, and finds many advocates." Of course by "common" it is not meant to be inferred that the practice is general.

Broken rail objectionable.

I consulted several eminent engineers and railway managers of long experience who have experimented with a broken rail, and they all concur in stating that it is with the very greatest difficulty a track can be kept in proper line and surface if laid with broken joints. They told me that many engineers had advocated the idea of placing the joint between the ties, and, in fact, many roads are laid in this way; but they maintained that the proper place for the joint is directly on the tie, in accordance with the practice in this Colony and Victoria, if not in all the Colonies.

Gradients.

The inclines, or grades (as they are called in the States) are in many parts of America very severe. The heaviest gradients between New York and San Francisco are on the Central Pacific Railroad, stated by Mr. Higginbotham to be no worse than 1 in 50. There are about 66 miles over the Sierra Nevada which average for one stretch 116 feet per mile, or 1 in $45\frac{1}{2}$ feet.

In order to furnish more exact information on the subject of American iron bridges than can be obtained from any notes of mine, I subjoin the accompanying letter from Messrs. Wilson Brothers & Co., civil engineers and architects, of Philadelphia. I feel satisfied that it will be found worthy of consideration,

whether or not the Government should enter into contracts with constructors of iron bridges in the United States:—

Iron Bridges.

Messrs. Wilson Brothers & Co., to Augustus Morris, Esq.

No. 410, Walnut-street,
Philadelphia, Pa., 24 November, 1876.

Dear Sir,

We enclose a sheet showing the general plan, &c., of our truss bridges,* and give below the prices delivered at New York of the iron-work for several lengths of spans; also the cost of erecting the bridges *in this country*. By adding to these figures the freight from New York to Australia, and any expenses of handling, &c., in Australia, also a percentage for the additional cost of erecting, over what it would be here, if any, your engineers can arrive at the approximate cost of our bridges built in Australia.

* See Appendix.

Prices.

Iron Bridges for Railroads, single track—gauge, 4 ft. 9 in.

50 feet span—Weight of iron-work per foot lineal of bridge, 400 pounds.
Cost ,, ,, ,, at 5 c. ℔ lb., $20.

100 feet spans—Weight of iron-work ℔ foot lineal of bridge, 550 pounds.
Cost ℔ foot lineal of bridge, @ 4¾ c., $26·12.
,, ,, ,, for erection, $5.

150 feet spans—Weight of iron-work ℔ foot lineal of bridge, 800 pounds.
Cost of iron-work ℔ foot lineal of bridge, @ 4¾ c., $38.
Cost ℔ foot lineal of bridge for erection, $6.

200 feet spans—Weight of iron-work ℔ foot lineal of bridge, 1,000 pounds.
Cost ℔ foot lineal of bridge, @ 4¾ c., $47·50.
Cost ,, ,, for erection, $8.

The foregoing prices are all in American currency, and are figured for a floor-system, like that marked No. 5 on the enclosed lithograph. If floors of iron beams were required, the *extra expense* would be,—for four lines of iron stringers $9 ℔ foot lineal of the bridge; and for two lines of iron stringers, $6 ℔ foot. The moving loads are assumed at 2,500 to 3,000 pounds ℔ foot lineal of the bridge, and 10,000 pounds ℔ square inch is the maximum tensile strain allowed on the wrought iron. The prices here given are what can be had at the present time, and are of course subject to change corresponding to any changes in the rates for labour and materials from those now ruling.

Plans can be modified.

We think that from the plans and above figures your engineers can form a correct opinion as to how our bridges compare with those your Government have heretofore been building. Your engineers might wish to make special requirements to provide for peculiarities in your railway service not existing here; if so, we can modify our plans to conform to such requirements. In this connection we would call your attention to the difference between our construction and that of English engineers. Instead of riveting we use *links* for our lower chords and main carrying rods, with *pin* connections. We avoid

Links instead of rivets.

the continual re-placing of rivets, which is necessary in all riveted bridges. We use less weight of iron; every part of our work is finished in the shop, and the whole bridge is erected complete in our shop yard before being shipped, so that we know positively that everything is right. Our bridges can be erected rapidly; there is no drilling, chipping, or fitting to be done on the erecting scaffold, the trusses conform readily to changes of temperature, no after adjustment is required, and after a bridge is once erected the only repairs necessary are to keep it well painted, and to renew when required any timber that may be used in the floors. Quickly erected.

Respectfully yours,
WILSON BROTHERS & CO.

I would say, once for all, that, in recommending trials of American railway plant, I am actuated solely by a desire to save the Colony money, and to provide at the same time superior material to that hitherto imported. I look upon all or any of them merely as models on which I hope soon to see all the railway and other plant, required for public or private service, made in New South Wales out of the raw materials, whether of iron or wood, which abound in such great quantities and of such excellent qualities in so many parts of this country. Plant to be manufactured in Colony.

But until we can manufacture for our own requirements, I imagine that the cheapest and best markets should be sought out.

As it has been learned by experience in the United States that the best and cheapest railroads are those which are well graded and properly ballasted, so also it has been found that the better the rolling stock the less is the liability to accidents; and consequently very great attention has been directed of late to the equipment of their railways by American engineers. The manufacturers have produced a locomotive engine which, for simplicity of structure, for power and economy in working, as well as for cheapness, compares most favourably with those of England or Belgium. American locomotive.

I was unceasing in my inquiries on this subject. I consulted those eminent engineers who were sent by the Russian, the German, the Austrian, and other European Governments, to report on American railroad plant, and my conclusions are theirs.

Price of locomotive.

They gave the preference to the best American locomotives over the English, for the requisite qualities; and I am enabled to say that a fair number of these locomotives, provided with copper furnaces and tubes, instead of the more commonly used steel ones, can be laid down in Sydney for £2,000 each, or £1,000 less than for those contracted for in England. The boilers of the best engines are now caulked on the concave method known as "Connery's," which really increases their strength 25 per cent., and I would recommend that concave caulking should be insisted upon in all Government work where caulking is required.

Concave caulking.

Smoke-consumers.

A great improvement too has been introduced into the furnaces of the locomotives on the Philadelphia and Reading Railroad, by which all the smoke is consumed, and the risk of danger from sparks almost entirely obviated. The saving in fuel by this invention is said to be considerable, and I think it must be so. The cost of this addition to a locomotive, including royalty, is about £20. This smoke-consumer is also applicable to stationary engines. Tubes with funnel-shaped mouths are conducted from the front of the locomotive *over* the arch of the furnace, and the draft thus directed accomplishes most satisfactorily the object intended. This invention has also been applied with admirable success to the locomotives used on the Harlem or Underground Railway of New York.

Head lights.

American locomotives have, it appears to me, more perfect head lights than those I have seen in this Colony, which must be a great advantage to the drivers, and contribute to the safety of the trains.

Comparison between Fairlie and Baldwin locomotives.

Perhaps over the more perfectly ballasted lines of this Colony, the relative merits of American engines may not be so apparent, unless the comparison between the Fairlie and Baldwin locomotives on the admirably constructed English railroad from Vera Cruz to the city of Mexico may be considered sufficiently demonstrative.

The subjoined schedule was furnished by the officials of the Mexican Railroad Company, and, I think, fairly shows the superiority of the Baldwin engines, which, however, are now somewhat improved.

A.

COMPARATIVE Statement of Running and Repair Expenses of Baldwin and Fairlie Engines on the Railroad from Vera Cruz to the City of Mexico.

Class of Engine.	From	To	Miles run.	Oil.	Tallow	Waste.	Packing.	Wood.	Coal.	Total cost of Running Expenses.	Total cost of Repair Expenses.	Total cost of Running and Repair Expenses.	Remarks.
				Pounds.	Pounds.	Pounds.	Pounds.	Cords.	Pounds.	\$ ¢	\$ ¢	\$ ¢	
No. 13, Baldwin	7 Dec., 1873	31 Dec., 1874	31,141¾	3,541	1,800½	232¾	53¾	1,142¼	96,622	10,438 62⅛	1,207 70¾	11,646 32⅞	Passenger trains between Va. Cruz and Orizaba.
No. 38, Do.	,,	,,	30,028¼	2,975	2,37	218	44	1,121¾	90,526	9,863 55⅜	1,526 87⅛	11,390 42½	
No. 28, Yorkshire Fairlie, 16″ cyl., 22″ stroke, 44″ wheel ...	6 Nov., 1873	,,	19,082¾	4,495	1,165	333½	81½	1,363½	253,637	10,688 66⅜	2,834 75⅞	13,523 42¼	Mixed trains between Va. Cruz and Orizaba.
No. 29, Do. do. do. ...	29 Nov., 1873	,,	12,686	3,123	790	252	31	978¾	146,082	7,532 83⅜	3,100 88⅞	10,633 72¼	
No. 30, Do. do. do. ...	22 Jan., 1874	,,	15,920¾	3,843	1,094	289	35¾	949¾	124,582	7,990 20½	2,702 70⅛	10,692 90⅝	
No. 31, Do. do. do. ...	8 Mar., 1874	,,	15,509¾	3,479	892	248	36½	930½	105,602	7,561 21¼	2,741 08¼	10,302 29½	
No. 32, Bristol Fairlie, 16″ cyl., 20″ stroke, 42″ wheel ...	1 Sept., 1874	,,	4,346¾	1,441	449	112	16¾	378½	169,100	3,190 41	790 07½	3,980 48½	Passenger and freight trains between Orizaba and Ba. del Monte Cumbres, 4% grade.
No. 33, Do. do. do. ...	,,	,,	3,014½	738	313	66	8¾	276	103,600	2,105 10⅞	795 20½	2,900 31⅜	

NOTE.—The cost of Running Expenses includes Wages of Drivers, Firemen, &c., &c.
Repair ,, ,, Wages and Material used for repairs.

Cost of Running and Repair Expenses per mile :—

Baldwin, No. 13	37·40 ¢
,, No. 38	37·93 ,,
Fairlie, No. 28	70·81 ,,
,, No. 29	83·82 ,,
,, No. 30	67·16 ,
,, No. 31	66·42 ,,
,, No. 32	91·51 ,,
No. 33	96·21 ,,

I also obtained a copy of the monthly report of the "*Amount of fuel, cost per mile, and miles run,*" of 69 locomotives on the Boston and Maine Railroad, which may be valuable to compare with similar expenses in this Colony. Consumption of fuel.

Many of these locomotives have been running for a long time and are not equal to the more improved engines.

The average quantity of coal used per mile was 2,000 lbs. to 46·16 miles, or 47·66 lbs. per mile. When wood was used, the average was one cord to 28·25 miles.

Some of the locomotives only used 16 lbs. and some 20 lbs. per mile, while others required 60 lbs. per mile, dependent. doubtless, on their speed.

The following statements show the comparative working of the Baldwin "Consolidation" and "Pen-wheeled," engines, on the Pennsylvania Railroad. The work done by these engines, as given in the schedule, extended from 1st January to 1st July, 1876.

The large amount of work done by the Consolidation engines of class I in a short time shows that they do not need the constant repairs which it has been asserted such engines would require. I found it was a commonly received opinion that though Consolidation engines haul more cars in a single train than lighter engines, they could not do so much work in a given time. The statements of the officials of the Pennsylvania Railroad and the figures given below leave no grounds for such apprehensions. These engines were hauling trains on the same schedule as the Company's ordinary 10-wheel engines work on, and of course, owing to fluctuations in traffic, engines have often to be run empty or with half-trains, so that the average train is very much below the usual load. Pen-wheeled and Consolidation engines.

The maximum load on a level division, with which the men are expected to make time, may be taken at 90 cars, though on one day an engine actually hauled 110 cars into Harrisburg.

I would state that class I, referred to, has cylinders 20 by 24, driving wheels 49 inches in diameter—total weight, 100,000 lbs.,

and on the "drivers" 88,000 lbs. Class D has cylinders 18 inches by 22 inches, driving wheels 55 inches diameter; weight, total, 77,000 lbs.; on drivers, 54,000 lbs.

I have photographs of both these patterns of locomotives as made at the Baldwin Works in Philadelphia.

One of the partners in these works is an English engineer who had the management of the Pennsylvania Railroad for many years, and who ought to know, as he professes to do, the comparative merits of the English and American locomotives; and I do not think he is so imprudent as to send to this Colony one of his firm's engines, on the understanding that it is not to be paid for unless it is in all respects after trial equal to the English locomotives in use here, without feeling well assured that his locomotive will stand every necessary test. I furnished the Baldwin Company, as well as others, with Mr. Rae's admirable and exhaustive Report on the Railways of New South Wales, from which the nature of the gradients on all our lines could be learned, so that the difficulties to be encountered are known to them.

PENNA RAILROAD COMPANY,
Philadelphia and Erie R. R. Division.

HOWARD FRY, Superintendent,
Motive Power.

STATEMENT "A."

Engines of Classes "I" and "D" compared.

Division.	Class.	Average pounds of Coal per car-mile.
Western (between Ove and Langdon's), heaviest grade	"I"	3·8
Do. do. do.	"D"	4·7
Eastern (between Renovo and Jersey Shore), heaviest grade	"I"	2·7
Do. do. do.	"D"	3·5
Susquehanna	"I"	2·5
Do.	"D"	3·4

STATEMENT "B."

Performance of "I" engines on P. and E. R. R. Division.

Engine.	Division.	Engine mileage.	Actual mileage of cars.	Actual number of cars in train hauled each engine-mile.
1004	Western	22,924	887,163	38·7
1011	Eastern	24,402	1,730,310	69·4

STATEMENT "C."

Performance of "I" engines on Susquehanna Division of N. C. Railway.

Engine.	Division.	Engine mileage.	Actual mileage of cars.	Actual number of cars in train hauled each engine-mile.
13	Susquehanna...	10,592	868,646	82·0
14	Do.	9,248	744,973	80·6

NOTE.—"I" engines are the "Consolidation" pattern, 8 drivers and 2-wheeled truck.
"D" engines are the "Pen-wheeled" pattern, 6 drivers and 4-wheeled truck.

I have been thus particular in giving what I had time to learn in respect to American locomotives, because I feel I am in some measure responsible for the advice I have given to try one on our railroads. And I am glad to be able to say, in consequence of Mr. Higginbotham's report, the Victorian Government ordered two of "Rogers's" American locomotives, which ought to arrive in Melbourne during the month of May.

American passenger cars.

It is a question of taste whether the English or American arrangements of the passenger cars are more comfortable, but I think where the traffic is heavy the latter are more convenient. For suburban passenger traffic and for excursions the American cars, I should say, are altogether more suitable.

Closets.

There is one enormous advantage they have over English carriages—which is, the system of always having closets in the carriages; and I must take leave to differ with Mr. Higginbotham when he implies their offensiveness is greater than their convenience.

Cistern for drinking water

I never heard a complaint in regard to them, and cause for any could be readily remedied. In each of the three cars ordered for this Colony—1st class passenger, 2nd class passenger, and sleeping cars—care has been taken to have both a ladies' and gentlemen's toilet room, and also a cistern to hold drinking-water accessible to all the passengers.

Miller platforms safer in collisions.

There is no question but the American passenger cars, with their Miller platforms, are safer in case of a collision than the English, which are always "telescoped" when such an accident happens, and consequently accompanied with greater loss of life or with more serious injuries to those who escape alive than would otherwise occur.

The strong beams or joists, extending from the extreme end of one platform to the extreme end of the other, on which the carriage is built, doubtless cause it to weigh more per passenger carried than an English one, but American engineers prefer, in this case, safety to lightness.

Sleeping cars.

The comfort, I may say the necessity, of the sleeping cars on long lines of railroad is too well understood to require insisting upon. Sleeping cars mostly run on eight wheels—two trucks of four wheels each, but twelve wheels are common enough, and even sixteen wheels are used on a few of the Pullman Cars. The Silver Palace Cars on the Central Pacific Railroad have only eight wheels.

Easy motion.

To insure the easy motion of the sleeping cars they invariably are hung on numerous elastic springs, and many of the Pullman Cars are run on paper wheels, having steel tires.

Diameter of wheels.

The usual diameter of the passenger car wheels is 33 inches, and they are made of cast iron, but I think Mr. Higginbotham is mistaken when he says that "there are difficulties in casting them larger." I am under the impression that there is no difficulty in casting wheels even as large as forty inches, for I saw many such at the Exhibition in Philadelphia.

The objection that cast-iron wheels are "never either perfectly balanced or truly cylindrical" has been met by planing, either before or after the wheel has been used.

Mr. Lobdell, of Wilmington, Delaware, has within the last year or two patented and made a wheel-lathe suitable for turning cast-iron chilled wheels. This wheel-lathe is so constructed that the tread of the wheel may be turned off without taking it from the axle. Cast-iron wheels turned.

On the Wilmington and Baltimore Railroad, wheels such as are by most roads broken up and turned over to the foundry for recasting, on account of being flat, worn, and having sand-blisters, have been turned and have made $66\frac{2}{3}$ per cent. more mileage than before they had been turned, and yet they were only an average wheel when put new under cars. There are other instances where wheels have run 26,000 miles after being turned. Longer life.

I think, however, that the time has arrived when the whole system of car wheels and axles must be changed, whether on American or English cars, passenger or freight.

I have repeatedly in my reports from Philadelphia drawn attention to the "Miltimore wheel and axle," and I forwarded a model of the invention to this Colony. The Miltimore invention consists of a compound axle—one fixed, and the other in form of a sleeve, revolving, the wheels being independent one of the other, and of course loose. As described in detail it is as follows:— Miltimore wheel and axle.

"It is a compound axle, involving new principles as well as new features of construction—that is, the principal axle is fixed, while a secondary one, made of wrought-iron, has wheel-sets upon which the wheels may revolve independently of it or in conjunction with it, on the brass bearing round the fixed axle, which, as one piece passes through the secondary axle, and at each end through a cast-iron nut into a pedestal block, and is firmly held in position by a steel pin; the end of the fixed axle is in communication with a reservoir, holding the lubricant, which is prevented from wasting, between the surfaces of the fixed axle and pedestal block, by a cork held in position by a washer and a hollow screw plug, which permits the lubricant to flow through Description.

it and a horizontal passage, and thence down a vertical passage in the underside of the fixed axle, to the bearing. If oil is the lubricant, a pin is used in the vertical passage to regulate the flow, but if grease is used the pin is removed.

"The wheels are held firmly in position, as to width, on the secondary axle by the long bearing of the wheel seat, and its shoulder on the inside and on the outside by the cast-iron nut already mentioned.

"The pedestal-block, with the reservoir for the lubricant, and the oil drip, are made of one casting.

"A washer against the pedestal-block prevents end play of the wheels and secondary axle.

"An annular ring holds the oscillating-box in position, and at the same time permits it to accommodate itself to slight changes of the axles due to shocks.

"A slot through the threads of the cast-iron nut permits sufficient lubricant to pass through it to lubricate the wheel upon its wheel seat.

"The journal of the fixed axle is tapered, and $\frac{6}{100}$ of an inch smaller in diameter than the box, which, revolving, presents its entire inner surface for wear.

"The construction is such that it seems almost perfectly to exclude dust, as under the microscope, after four months continuous wear with the same charge of grease, an examination only showed slight traces of dust, and no particles of grit, no cuttings of metal of any size having been found."

The above description, as also all the principal facts, were supplied to me by the experts employed by the Eastern Railroad Association, consisting of forty-three Companies, which have combined to test every improvement likely to be of value to their lines, or in any way to affect their interests.

Trials.

It has been put to many severe tests, but I only witnessed it in operation on the West End Railroad which ran round the

Exhibition grounds at Philadelphia. This railroad, which was not ballasted, and therefore rough after rain, had a gauge of 3 feet, with a double track each $3\frac{1}{2}$ miles long.

It was a very crooked road, being made up almost wholly of curves, in order to run near all the principal buildings on the Exhibition grounds. Many of these curves were on the heaviest gradients, some having a radius of 250 feet on inclines of 155 feet to the mile. West End Railroad.

In ordinary work one engine, with the lever dropped back three notches, and carrying 25 lbs. less steam, could draw six cars, fitted with Miltimore trucks 24,000 lbs. heavier than the others, the trucks having been made for larger cars, and 800 passengers, more easily than a similar engine could draw five cars with 666 passengers. Indeed, I have often observed that the lighter load on the ordinary wheels required the aid of an additional engine at the steepest incline with the sharp curve, while "the Miltimore" ran without extra assistance. Less friction.

It was found that the ordinary cars wore out three sets of cast-iron break-shoes, while on the Miltimore cars only one set was required during the same period of time, and that was not worn one half. The wear of iron on each ordinary car during the six months of trial was 22·92 lbs., and on the Miltimore cars only 3·125 lbs. Longer life of break shoes.

The average consumption of grease on a car equipped with the Miltimore axle was 26·977 cubic inches of grease, against 268·835 cubic inches of black oil (petroleum) consumed by each ordinary car in 90 days; that is, the 26·977 cubic inches of grease consumed by the Miltimore car for 90 days is 10·035 per cent. of the 268·835 cubic inches of oil. I may here point out, what tho experts failed to do, that the Miltimore cars used a comparatively newly invented grease called "Albany," which is fully three times more lasting than the ordinary lubricants, and in so far accounts for the smaller quantity used. After running two months the common black oil was taken out, in order to try the Albany grease. The latter was used four months without having Small consumption of grease.

to be replenished, and was found to be lowered only one inch in the oil reservoir, which, being closed by a light screw cap, as already described, excluded all dust and grit.

Greater wear of ordinary wheels.

It was almost impossible to arrive at any correct data as to the relative wear of the rival wheels, as no casts had been taken previous to their commencing running.

An examination of the tread of the ordinary wheels showed many flat spots in the wheels, and some cutting in the flange. Two sets of trucks had been removed on account of flat wheels.

Less wear of Miltimore wheels.

On the other hand, the Miltimore wheels showed the tread to be good, not having any flat spots, or but little flange wear, simply that of brightening up the metal from $\frac{3}{8}$ to $\frac{1}{2}$ an inch on the flange.

The Miltimore, as well as the other wheels are cast-iron (chilled). Of course there were no data to determine the relative wear and tear of the line itself under the operations of the two systems of car wheels, but they must have corresponded with the wear and tear of the wheels.

Superiority of the Miltimore.

These facts seem to me clearly to demonstrate the superiority of the Miltimore wheels and axles over those at present in general use.

As a consequence of "removing all tortional strain from the axle, and lessening the vibratory and vertical strain on the wheels," their size can be increased. I learned from the Manager of the Central Vermont Railroad that he had a train of five large passenger cars fitted up with 40-inch wheels, mounted on the Miltimore axle. He had tested them for eighteen months on regular fast passenger trains, running from 150 to 200 miles daily. The Superintendent of this line remarked that these wheels are "less liable to mount the rail," and when a set was taken out for inspection there was no perceptible wear in any of its parts.

Whipple's report

Mr. S. M. Whipple, the principal expert of the Associated Eastern Railroads, reports that he is acquainted with all the

tests which have been made, and that he is engaged in making a thorough and exhaustive test of the Miltimore axle on the Boston and Albany Railroad; and "he expects to be able to show that the Miltimore compound fixed and revolving axle, with independent wheels, is safe, and in every way more economical, both in construction and maintenance, than the axle in common use." "And more," he expects "to show that this improved axle is a practical solution of the whole question of railway car journals, wheels, axles, and their proper mode of lubrication."

I was in hope that the passenger and sleeping cars ordered from the United States would be equipped with the Miltimore axles, so admirably adapted as they are for our lines with their steep gradients and sharp curves.

Some Miltimore wheels to come to Colony.

Unfortunately, after I left New York, Mr. R. W. Cameron, on whom the responsibility lies of sending a good sample of the American passenger cars, changed the arrangements.

From his stand-point he cannot be blamed. The Miltimore invention has not been long enough before the railway public to have been adopted on any of the best lines, and Mr. Cameron could scarcely be expected to endorse a matter to which he had never given any attention.

Some wheels and axles are, however, to be sent free of cost, so that their advantages may be tested by our own engineers. When tried it will be impossible to tell by any difference of motion whether the Miltimore cars are on a curve or straight line, so free are they from any oscillation.

Whatever doubt may prevail as to the propriety of adopting the American passenger cars on our railroads, I imagine there is none existing in regard to the merits of the American freight waggons—especially if supplied with the Miltimore axles.

Freight cars.

Mr. Higginbotham says that the ordinary box freight cars on the Central Pacific Railroad weigh 19,860 lbs. each.

This weight is that of the "Combination" cars, of which I obtained and forwarded a working plan on my way to Philadelphia.

Combination cars.

The Combination car is suitable for all kinds of freight, including live-stock, and will carry with safety 30,000 lbs. The ordinary freight car only weighs 16,000, and will also carry 30,000 lbs.

The trucks for these cars could be imported from the United States at a very much less cost than they have been from England.

Wrought iron tanks can be imported cheaply.

Trucks for freight cars made with the best wrought-iron frames, four wheels to each truck and two trucks to each waggon, could be delivered free on board in New York for a sum not exceeding £70, royalties included, at present rates for iron.

All of these trucks would be equipped with the Miltimore axle and independent wheels, and would be complete in every part, and it must be remembered that these wheels will even outlast steel ones. Each part of the truck would be made to a *templet*, so that the various parts might be interchangeable, and fit for the corresponding place in any truck. The wheels, axles, and frames to be taken apart, that they might be stowed compactly for shipment at the lowest rate of freight; and as the wheels are loose, very little space would be occupied. I assume that the bodies of the waggons would be made in the Colony, either out of our own woods or from imported seasoned woods.

Bodies of cars to be made in Colony.

I observe that Mr. Higginbotham recommends the importation of seasoned woods of the best quality to build in Government workshops the required rolling stock.

Kiln for drying colonial timber.

In connection with this subject, I may be permitted to remark that if there are grown in this or the neighbouring Colonies various kinds of woods suitable for the construction of rolling-stock, it would be very little trouble and expense to build a kiln for kiln-drying timber. No matter how green the timber may be, a few days only are required for thoroughly seasoning it. And in the Exhibition in Philadelphia we saw a process by which the most rigid of our colonial woods can be bent *like whalebone* to any shape. Mr. Robinson, our Secretary, had a piece of our wood so treated, and it will be amongst the exhibits in Alfred Park.

I am certain that the bodies of all our passenger cars and freight waggons could be constructed in this Colony more advantageously than by importing; but the Superintendent should be a man thoroughly acquainted with all the American methods, and should likewise be a skilful draftsman. Such a man could be obtained, but not for less than £800 a year. It is, however, only by having skilled heads over the various branches that the railway plant can be made in this Colony and the work secured for our own people. Car construction.

I was a good deal surprised, when first I saw an American railroad, at the want of raised platforms at the stations. I soon however learnt to look upon the want of them not only as a matter of great economy, but of safety to the passengers. And notwithstanding what ought to be the better opinion of Mr. Higginbotham, I feel assured the American railroad managers will not generally adopt platforms. No platforms.

According to my judgment I think, with the American style of passenger car, and the great difficulty of preventing passengers—men especially—from getting on and off the cars while in motion, it is much safer that the platform should be about the same height as the rail; for then, in attempting to get on just as the train starts, or to get off just before stopping, the weight of the person would be thrown away from the rail and car, instead of against it, or alongside, as would be the case if the platform was as high as the lower step. I have been told of many fatal accidents which have occurred from persons attempting to get on cars in motion from what is known as the high platform, viz., up to the bottom step. Objections to platforms.

Perhaps it will not be out of place if I say a word of explanation in reference to what Mr. Higginbotham states about "compromising" of cars so as to make them suitable to run on lines of 4 feet $8\frac{1}{2}$ inches gauge up to 4 feet 10 inches gauge. He says "they (the cars) have wheels with broad *flanges*." Compromising of cars.

The State laws of Ohio require all railroads built in that State to be of a gauge of 4 feet 10 inches. The accepted standard of Ohio laws.

the United States being 4 feet $8\frac{1}{2}$ inches, it is evident that a car made to the latter gauge could not run over the Ohio roads; and as many of the trunk lines east and west of Ohio desired to run cars through without breaking bulk, they devised the plan of compromising the car, or, in other words the truck, which operation is accomplished by casting a wheel with broad *tread*—not flange. The tread of the wheel is usually about one inch wider than that of the ordinary wheel. The wheels are pressed on to the axle to a gauge of 4 feet $9\frac{1}{4}$ inches, that being $\frac{3}{4}$ of an inch wider than the standard gauge, and $\frac{3}{4}$ of an inch narrower than the Ohio gauge, thus permitting the flange of the wheels to pass safely through the frogs of both gauges without springing the axle or breaking the wheel; but on the Ohio gauge the car would run loose, with much lateral motion, while on the standard gauge it would run close up to the flanges of the wheel, making a train pull much harder in consequence of the wheels being a little too wide. Notwithstanding the Ohio law, I was told that some of the roads crossing that State are compromising the *track* at a gauge of 4 feet $9\frac{1}{4}$ inches, thereby permitting both the 4 feet $8\frac{1}{2}$ inch and the 4 feet 10 inch truck, or car, to run over their roads, which substantially accomplishes the same as to compromise the trucks, as above referred to.

Compromising the track.

Narrow gauge.

From all I could learn, there appears no reason to doubt the correctness of Mr. Higginbotham's opinion that there is no real economy in adopting the narrow gauge, especially if the traffic along the line is ever to be considerable; but to the low-cost railroads I gave no study, and can form no opinion of my own.

Expense attending breaking of gauge obviated.

The breaking of the gauge is no doubt a serious nuisance, but I believe much of the expense of it is to be avoided by the use of "Ramsey's Car-Truck Shifting Apparatus," a model of which I sent from Philadelphia. The usual method of shifting a loaded car or waggon from one truck to the other is by a *steam hoist*. The method is in itself effective enough, but the cost of the machinery is about £2,000. By Ramsay's plan the cost is only about £100, and its

operation is very inexpensive. The removal of the body of a car or waggon from trucks of different gauge is effected by having at each shifting station part of the track slightly depressed (say 18 inches); before running the trucks to be removed down a gentle incline into this pit, two narrow side trucks are placed on either side of the car to be lifted. From one to the other of these side trucks two beams, at suitable distance, are passed under the body of the car to bear its weight, when its own trucks run from under it, which they do in the pit. To place the loaded car on the trucks on another gauge, it is brought over the pit on the side trucks to that part of the incline where the waiting trucks can receive the King bolts and relieve the others of their load. There are many advantages incident to Mr. Ramsay's invention, which will doubtless cause its adoption, irrespective of its usefulness where the gauges are broken. I apprehend, however, it will come into play when the Victoria line with its wide gauge, and the Queensland line with its narrow one, meet that of New South Wales with its standard gauge. Mr. Ramsay offers the right of his invention to the Australian Governments for a small sum.

Knowing that the subject of continuous "power-breaks" excited a great deal of interest amongst all persons connected with railway management, I gave what attention I could to that branch of railway gear. I observed that in the estimation of disinterested engineers, such as the various European Governments sent to report on American railroads, the hydraulic system, as distinguished from the atmospheric, seemed to have the preference. They told me that, excellent as was the Westinghouse air break, its complexity, and liability to derangement in consequence, were serious objections. Acting under the best advice I could obtain, and seeing the system in operation, I came to the conclusion that the hydraulic break invented and patented by Mr. W. M. Henderson, a Scotch engineer, was, of all, the most suitable for the Australian Colonies. Having ascertained the fitness of an article for the purpose required, I always tried to select that one which could be more cheaply made in this Colony than imported, and I am in

Power breaks.

Westinghouse air and Henderson hydraulic breaks.

hopes that the Henderson Hydraulic Break will meet the requirements I have mentioned. It has many points of merit, arising out of the very great simplicity of the apparatus—its instant readiness for action—its economy in working, as steam is only used at the moment of applying the breaks, and directly to that purpose—and its cheapness in construction, consisting as it does of a few simple castings. It can be made in this Colony for less than half the cost of the Westinghouse Break, but the patentees expect the various Governments to purchase the right to make and use their invention. To test its efficacy I have had, by permission of the Henderson Hydraulic Break Company, apparatus made sufficient for one locomotive and six large American cars, or twelve English cars, at a cost of about £130. I imagine the same could be made here in the Railway workshops for about £100. This break is under the immediate control of the driver, and in no way interferes with the working of the hand breaks, than which it costs no more to maintain. A small quantity of strong solution of ammonia will not only prevent the water in the iron pipes from freezing at the lowest temperature, but will also preserve the pipes themselves from rusting. One advantage of the Henderson Break is that it can be applied to freight waggons without any great expense.

Cheapness of hydraulic break.

Turn-tables.

I think the "Railway Turn-tables," such as are used in the States, and indeed on both the American Continents, would be found of great use at our principal stations. They are made almost exclusively by Messrs. William Sellers & Co., of Philadelphia. These turn-tables, which are cast-iron, are simple in form, very durable and easily put in place, requiring comparatively inexpensive pits, and turning with ease.

There is no occasion to cover the pits, not even in roundhouses, as they are not deeper than 20 inches, and can be crossed by stepping into them.

The centre plates and the rolls are steel, making the turning easier.

The prices and weights of uncovered turn-tables are as follows, viz. :— Size, price, and weight.

	Price.	Weight.
60 ft.	£300	36,300 lbs.
56 ft. 1 in.	295	33,300 ,,
54 ft. 1 in.	290	32,800 ,,
50 ft. ex. heavy pattern	255	29,050 ,,
50 ft.	244	24,600 ,,

10 per cent. off.

The timber work, circular track, and rail for top of table are not included in above prices.

One man with a lever can turn with ease the heaviest engine. Easily operated. The power required to turn a table 50 feet in diameter, weighing over 24,000 lbs., is so small that $1\frac{1}{2}$ lb. pressure, applied at one end of the arms is sufficient to start its motion from a state of rest.

A table 30 feet in diameter is used in freight-depôts for turning waggons; it is also adopted on coal roads for turning at "tips."

The "Fisher Rail Joint" is considered an improvement. Rail joint. It consists of a double-headed U-bolt pattern, with base plates of either 22 or 24 inches long. The plate is bolted through the flanges of the rail, and receives the ends of two rails in its centre. It is said effectually to prevent "creeping" of rails, and to have several advantages over other chairs, especially inasmuch as it does not weaken the rail by requiring a hole to be bored through it horizontally.

I have already remarked that the easier motion on the Godley car springs. American railways may arise from the better springs used on the cars. I have myself tested one spring known as the "Godley," which is especially applicable to freight waggons and to buffers, on account of its strength, elasticity, and cheapness. It is a spiral spring, but differently constructed from any other. It will bear according to its size weights from 10 to 15 tons, and retain in full force its elasticity. They can be purchased for 2s. per inch in height.

For passenger cars I imagine arched flat springs are the best. Both kinds will be at our Exhibition.

Car-coupler. The American inventors are a good deal exercised in regard to car-couplers. I have had one made which is automatic in its action, and appeared to me to be what is required on our cars and waggons. It will I fear scarcely be in time for the Metropolitan Exhibition. If approved of, it can be made here, and the inventor expects only a small sum for the right to use it.

Improved pisto packing. "Richards's" improved spring packing for cylinders is well worthy of consideration, whether for locomotive, marine, or stationary engines. It consists in "the substitution of lugs and clips for bolts and nuts, giving a permanent and solid backing to the springs, and allowing the packing to be more rapidly and uniformly adjusted than with bolts and nuts."

This packing cannot come down, so that an engine in service cannot be disabled from that cause. It is said to save, as against the packing in ordinary use, half a ton of coal during a run of 100 miles by a locomotive. I cannot say that any tests to be relied upon in respect to saving of fuel have been made, but I have before me carefully taken weighings of the consumption of tallow by the old bolt-packing and by Richards's improved packing respectively.

Results of packing. The old packing was used in 1875 and the improved in 1876, on the same engines, with the following results:—

Engine No. 300.

1875, January to May (5 months)—813 lbs. tallow; 14,618 mileage. $6\frac{94}{100}$ lbs. for 100 miles run.

1876, January to May (5 months)—561 lbs. tallow; 12,370 mileage. $4\frac{53}{100}$ lbs. for 100 miles run.

Engine No. 49.

1875, same months—597 lbs. tallow; 12,204 mileage. $4\frac{89}{100}$ lbs. for 100 miles run.

1876, same months—614 lbs. tallow; 13,038 mileage. $4\frac{70}{100}$ lbs. for 100 miles run.

Engine No. 348.

1875, two months—319 lbs. tallow; 4,223 mileage. $7\frac{55}{100}$ lbs. for 100 miles run.

1876, five months—484 lbs. tallow; 9,940 mileage. $4\frac{86}{100}$ lbs. for 100 miles run.

Engine No. 219.

1875, five months—564 lbs. tallow; 10,023 mileage.
$5\frac{62}{100}$ lbs. for 100 miles run.

1876, five months—461 lbs. tallow; 9,716 mileage.
$4\frac{74}{100}$ lbs. for 100 miles run.

The general result is a saving of about 50 lbs. of tallow a month for each engine, or 600 lbs. for the year. My authority states that the packing is superior to anything he has seen, and that it is impossible to get out of order, requiring only a tenth of the usual labour to keep it in repair, and that labour need not be skilled.

Greater simplicity of Richards's packing.

The piston packing adopted in England has five parts to each spring, while Richards's has only three. In the best English packing the head of the bolt is out at the rings; while in America, with the same kind of spider, the head of the bolt is always next the centre. With this alteration the English is the old spider in use in the United States previous to the invention of Richards's packing.

Switches.

The "Wharton Switch" for sidings is generally preferred in the United States, but this is a subject on which it is not necessary to enlarge; I have a plan of this switch.

Improvement consequent on great extent of railroads.

Some improvement or other is being made every day in America; and when it is remembered that there are in the States and Canada more than 80,000 miles of railroad, it is not surprising that the engineers, many of whom are English, on so many miles should be in some things in advance of their rival English brethren, who have only 17,000 miles of railroad to design for.

Check system.

As is well known, the "check" system for passengers' luggage is a special feature of American railway management.

A metal disc with a number on it is fastened to every piece of luggage, and a duplicate of it is given to the owner. This enables the passenger to obtain his property without delay; or by giving the checks to an authorized carrier, it is delivered at his hotel or private residence for a small regulated charge.

Bad usage of luggage.

This latter arrangement is found a great convenience, and I never heard of any one suffering a loss by it. But the check system does not in American railroads protect passengers' luggage from bad usage by the porters. Generally speaking, that class of freight is knocked about in a most reckless manner, and I can assure travellers that leather trunks however strongly built will almost certainly be wrecked on a journey from San Francisco to New York. The Central Pacific Railroad is the only one I am acquainted with on which ordinary care is taken to prevent damage to luggage.

Numerous ticket offices.

The practice of having agents for the sale of railroad tickets and for receiving passengers' luggage in the principal streets of the cities is also a great convenience, and relieves the office at the stations from the crowds which would otherwise press round the ticket-window a few minutes before the trains start.

These agents send to the hotels or elsewhere for heavy luggage when desired.

Statistics of railroad accidents.

To conclude the information which I have attempted to give, I find that the total number of accidents to railroad trains in the United States were for 1875, the latest date to which I could obtain statistics, 1,201, resulting in 234 deaths and 1,107 persons being injured.

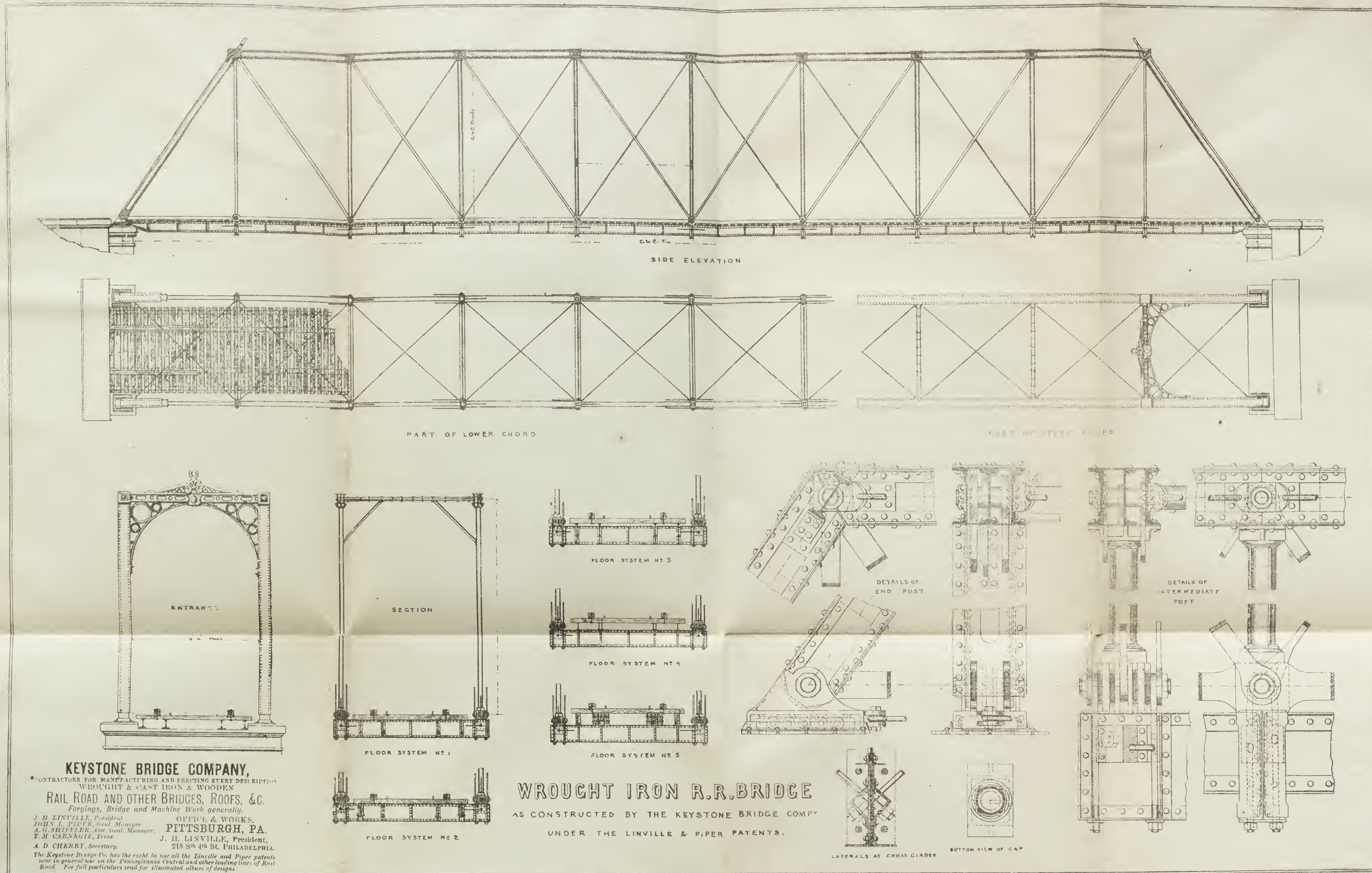
As I said in the beginning of this report, my statements are merely those of an unprofessional observer, trying to learn a few lessons which might interest those who can turn them to the advantage of this Colony and Australia generally. Exact knowledge I could not acquire, for it would have taken me many months to learn the technical terms alone of the multifarious subjects connected with railroads and their plant.

AUGUSTUS MORRIS,
Executive Commissioner to Philadelphia.

Sydney, 31st March, 1877.

[Diagram.]

Sydney: Charles Potter, Acting Government Printer. 1877.



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